

# Pharmaceuticals, Personal Care Products, Endocrine Disruptors (PPCPs) and Microbial Indicators of Fecal Contamination in Ground Water in the Helena Valley, Montana, USA



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# Introduction

- 22 PPCPs detected in ground water in the Helena Valley, both private and public supplies
- Associated with discharge from domestic wastewater
- Little is known :
  - Mobility or persistence in ground water or surface water
  - Human health or aquatic ecosystems effects
- Proposed Ground Water Rule: Multiple Microbial Fecal Indicators for public water supplies
  - Possible future monitoring coliphage, *E.coli*, enterococci

# Residential Development on the Valley Fringe



# Selected Previous Investigations on PPCPs and Coliphage in Ground Water

## ■ Hinkle et al, 2005, LaPine, OR

- ❑ Of 45 compounds found in wastewater only 9 found in GW - too reactive to serve as GW tracers
- ❑ Also found sulfamethoxazole (SMX), acetaminophen and caffeine in GW
- ❑ Coliphage detected 8 samples (considered to be field or lab contamination) but absent in replicate and repeat samples; probably attenuated before reaching sampled wells

## ■ Heberer, 2004, Berlin, Germany

- ❑ PPCPs are likely attenuated in ground water
- ❑ Loading rates between wastewater systems could be highly variable

## ■ Seiler, 1999, Reno, NV

- ❑ Caffeine (up to 0.23 ug/L) and PPCPs as fecal indicators in GW— unambiguous evidence of fecal contamination
- ❑ But caffeine is not conservative; probable nearly complete catabolism of caffeine in bacteria-rich septic system...
- ❑ Also found carbamazepine (anti-seizure), chlorpropamide (treats diabetes) and phensuximide (anti-seizure)

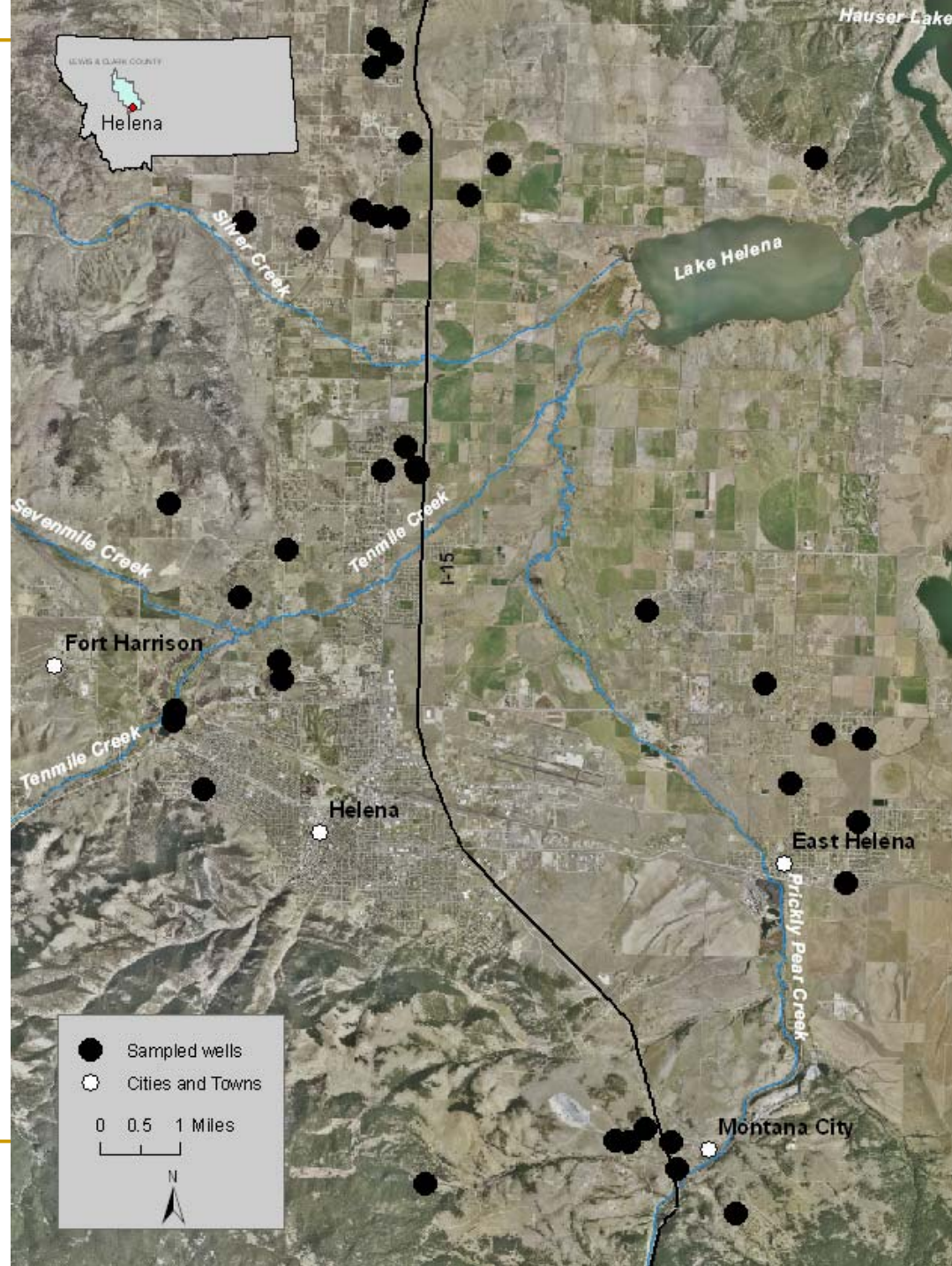
## ■ Godfrey and Woessner, 2004, Missoula MT

- ❑ Acetaminophen, caffeine, nicotine, codeine, trimethoprim (antibiotic) and carbamazepine in wastewater



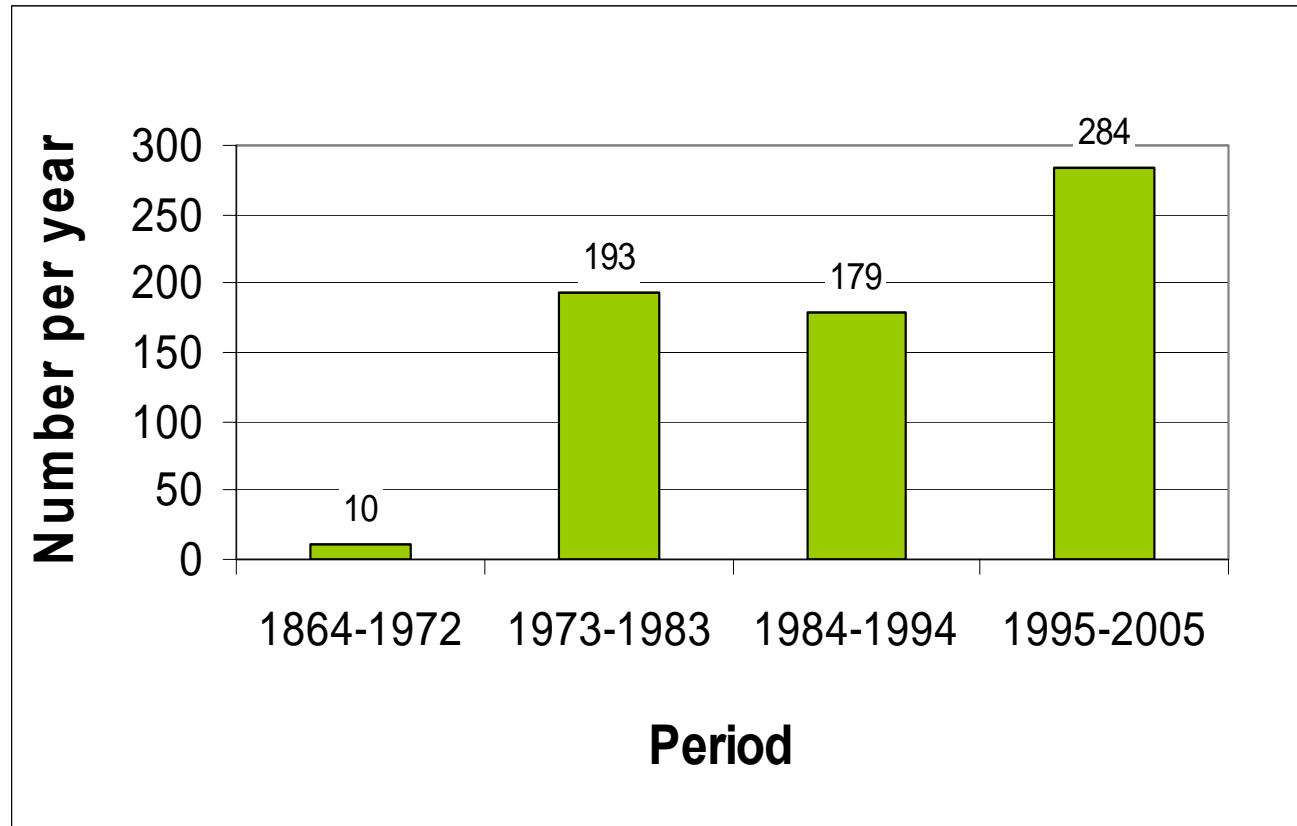
# The Helena Valley

- Rocky Mountain Foothills
- 330 sq. mi.
- City Limits pop. 28,000
- State Capital
- Previous investigators:
  - coliphage in 10 of 19 samples
- Mixed-use
  - Previous: Agriculture and metals-mining
  - Current: residential



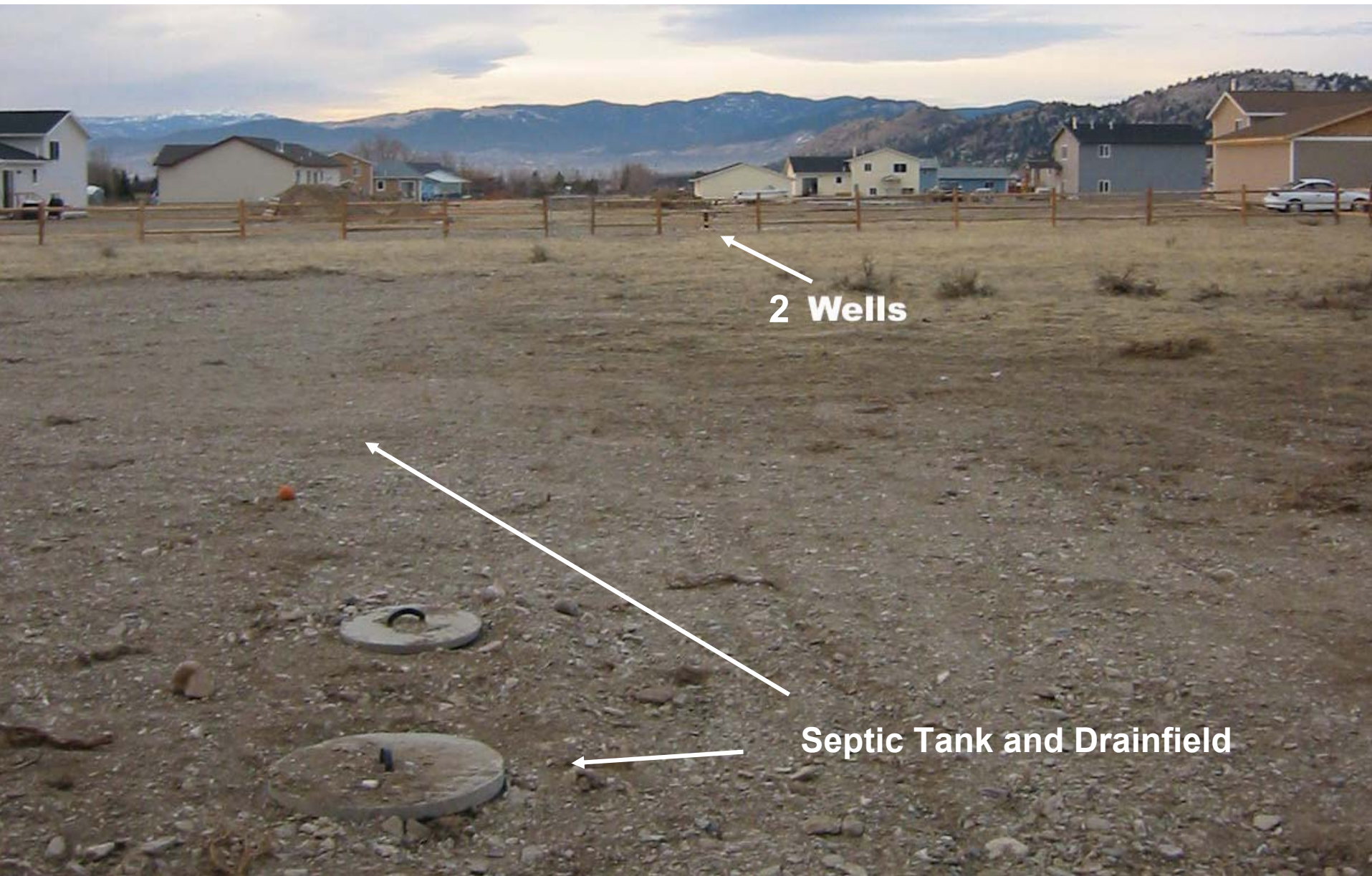
# Number of New Well Installations Per Year

- Residential development into areas with no central water or sewer





# Onsite Wastewater Systems and Drinking-Water Wells

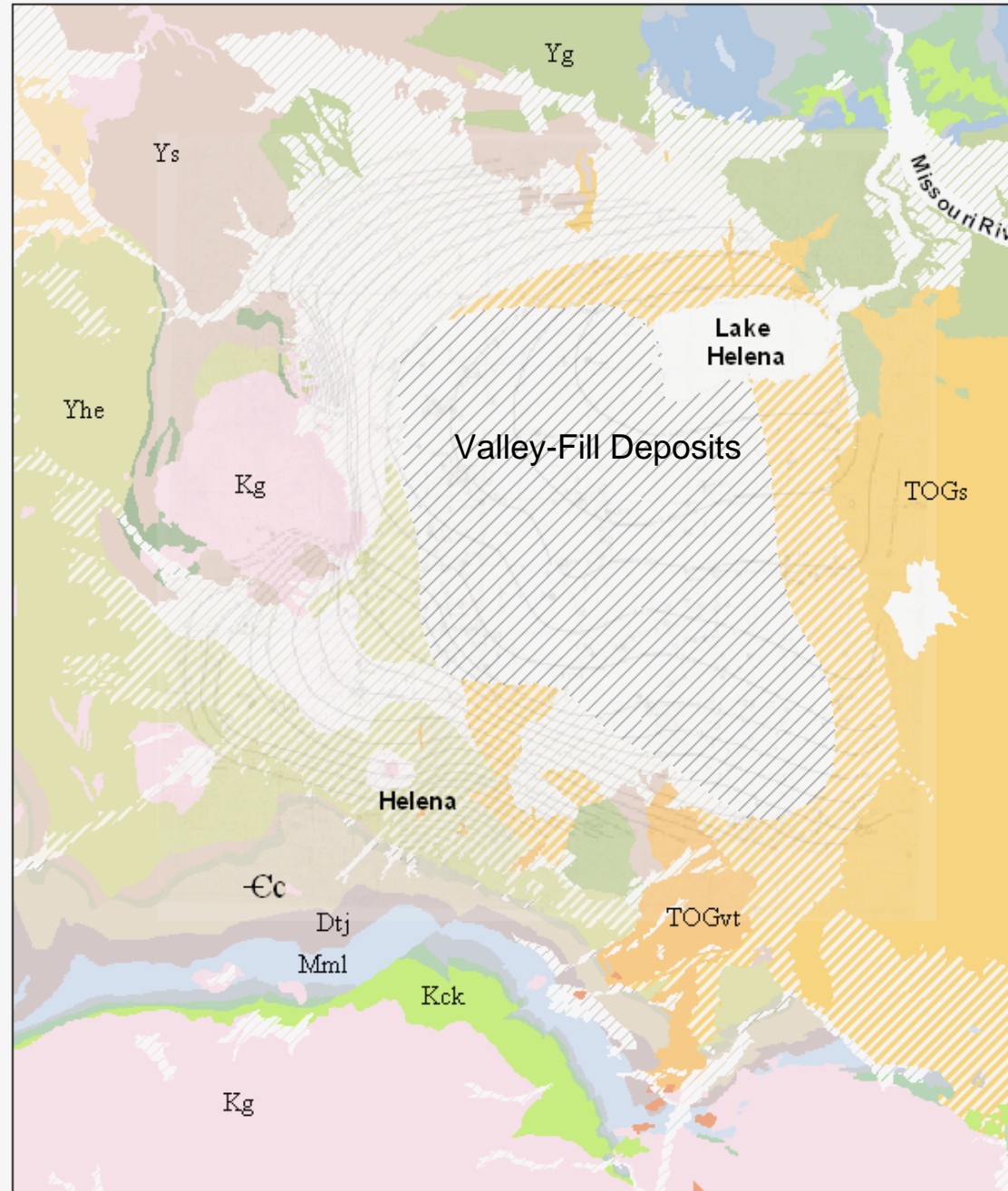


**2 Wells**

**Septic Tank and Drainfield**

# Helena Valley Hydrogeology

- Bedrock is Precambrian to Cretaceous age, folded and fractured, sedimentary, metamorphic and igneous
- Valley-fill deposits (Q/T age) function as one complex aquifer system
- Irrigation with imported Missouri River water
- Ground-water flow from south, west, and north margins to Lake Helena
- Calcium bicarbonate type ground-water quality



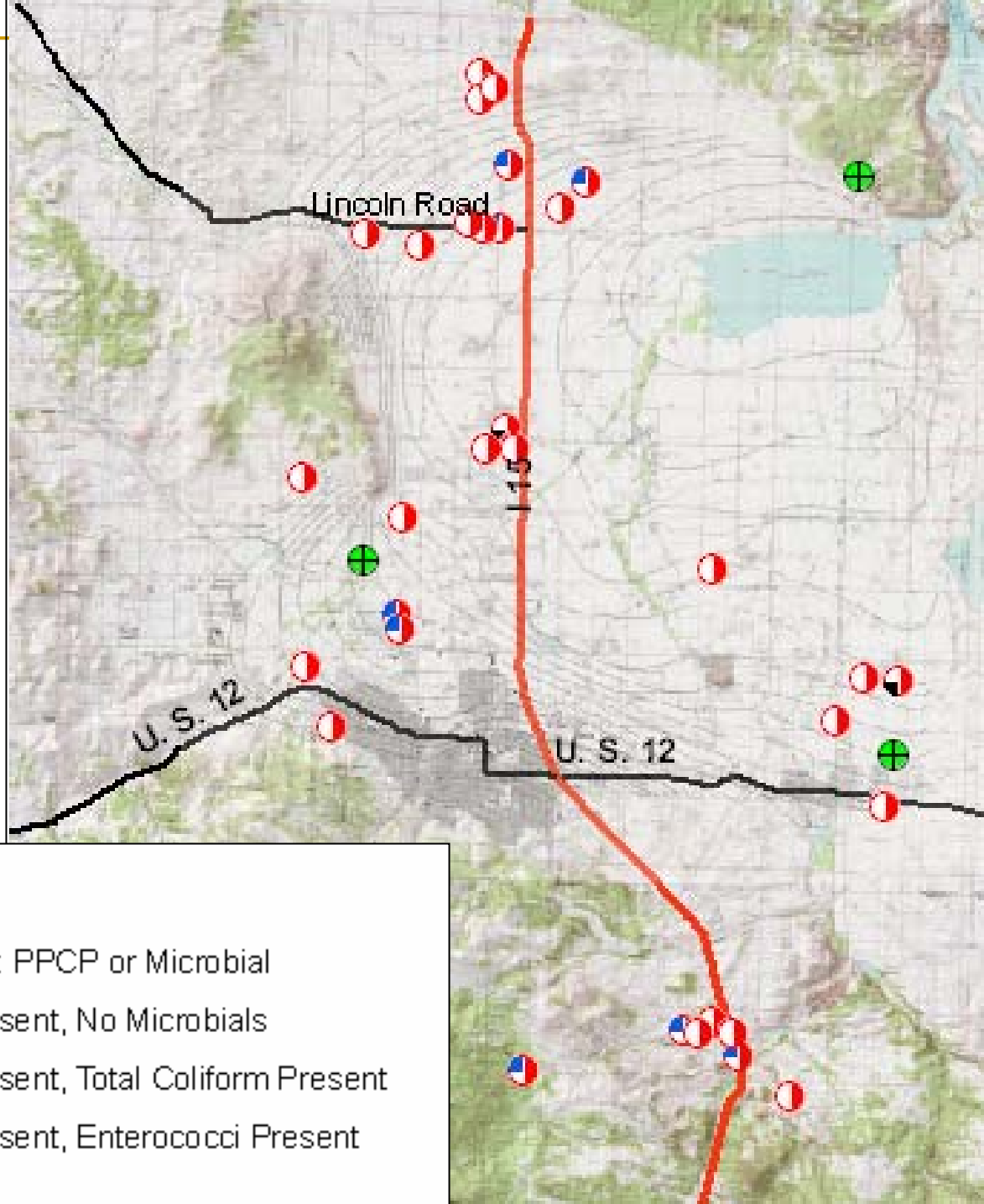


# Methods

- ❑ April, June, November 2005
- ❑ 35 wells sampled for PPCPs
- ❑ 38 wells sampled for microbial indicators
  - 12 wells completed in bedrock aquifers
  - 26 wells completed in valley fill deposits
- ❑ 18 public water supplies
- ❑ Wells flushed until stable field parameters
- ❑ Analytical;
  - Coliphage – EPA 1601 Male specific and somatic coliphage by two-step enrichment procedure
  - PPCPs – Sample prep by EPA Method 3535, used LC/MS/MS
- ❑ Each well site assigned unique GWIC ID number referenced to the Montana Ground-Water Information Center
- ❑ Well depths range from 39 – 425 ft

## PPCP and Microbial Results

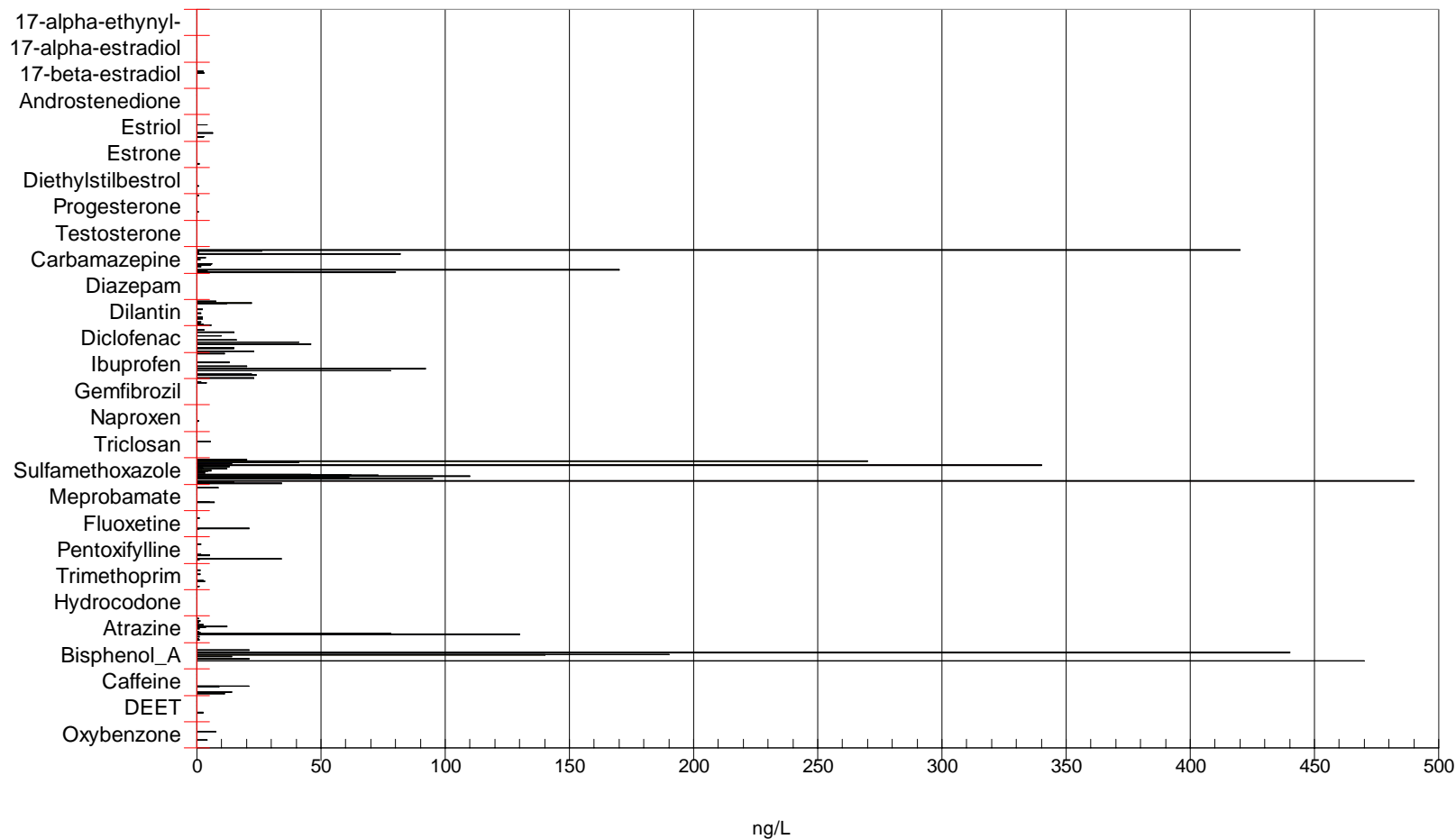
- PPCPs detected at 32 of 35 sites
- Zero coliphage detected
- Zero *E.Coli* detected
- 8 sites positive for total coliform in the presence of PPCP
- 2 sites positive for enterococci in the presence of PPCP



### Legend

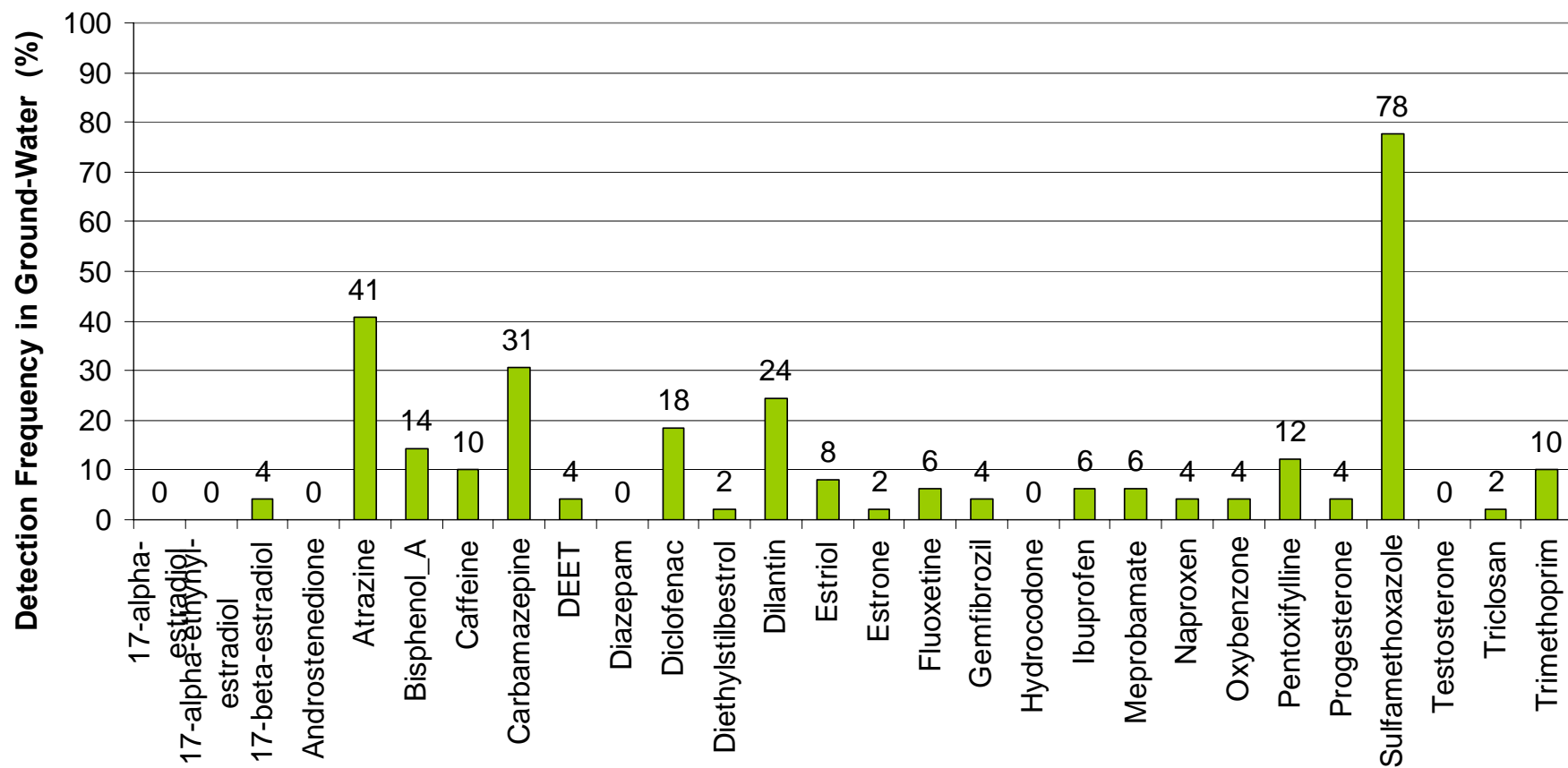
- No Detect: PPCP or Microbial
- PPCP Present, No Microbials
- PPCP Present, Total Coliform Present
- PPCP Present, Enterococci Present

# PPCP Concentrations in Helena Valley Ground Water, 2005





# Detection Frequencies of 28 PPCPs



# PPCP Concentrations

Five Most Frequently-Detected PPCPs	Maximum Concentration (ng/L)
Sulfamethoxazole (SMX)	490
Atrazine	130
Carbamazepine	420
Dilantin	22
Diclofenac	46

# SMX, Atrazine and Types of Wastewater Discharge

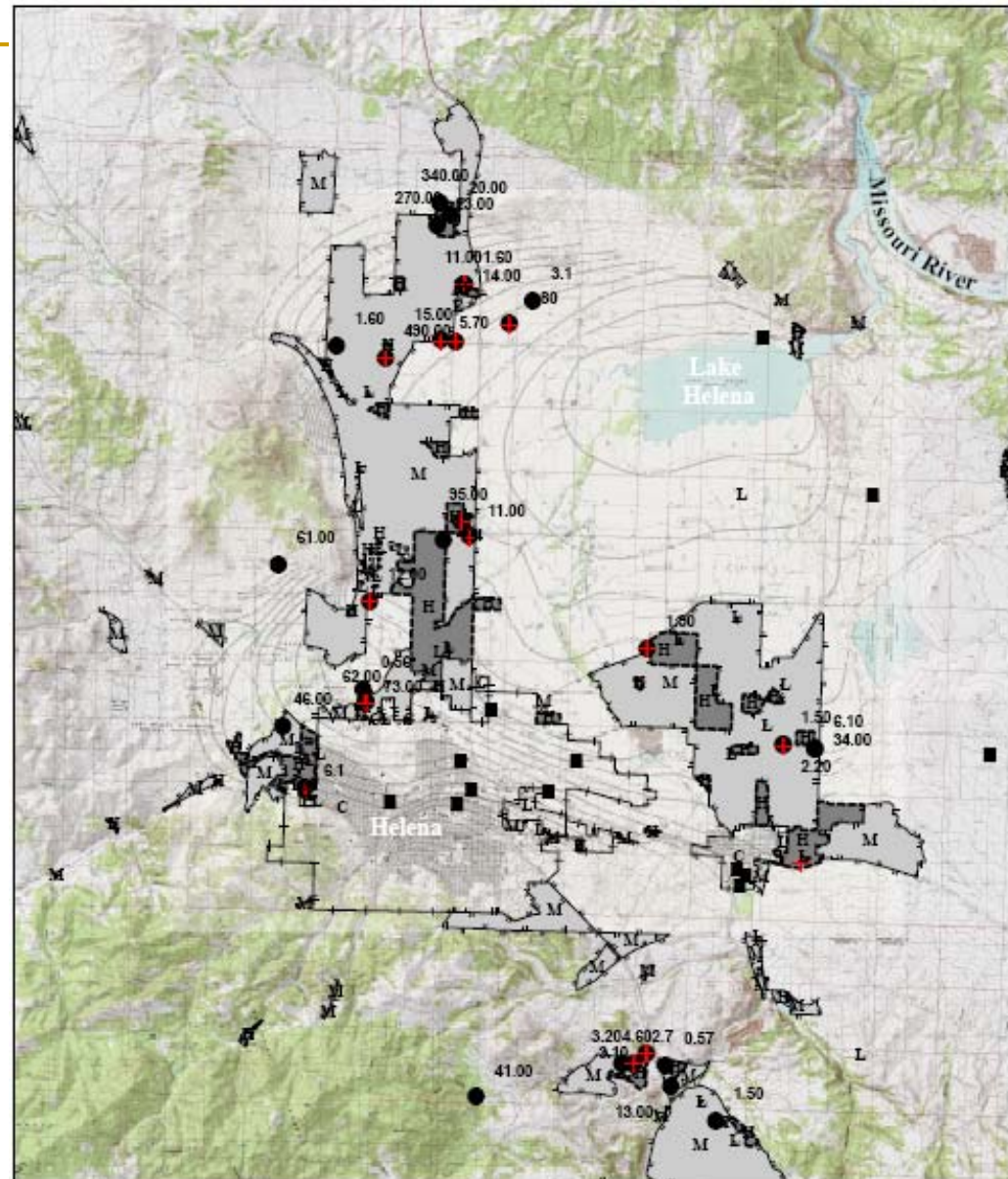
## Septic Tank Density

### ■ High:

- >300 septic tanks /mi<sup>2</sup>

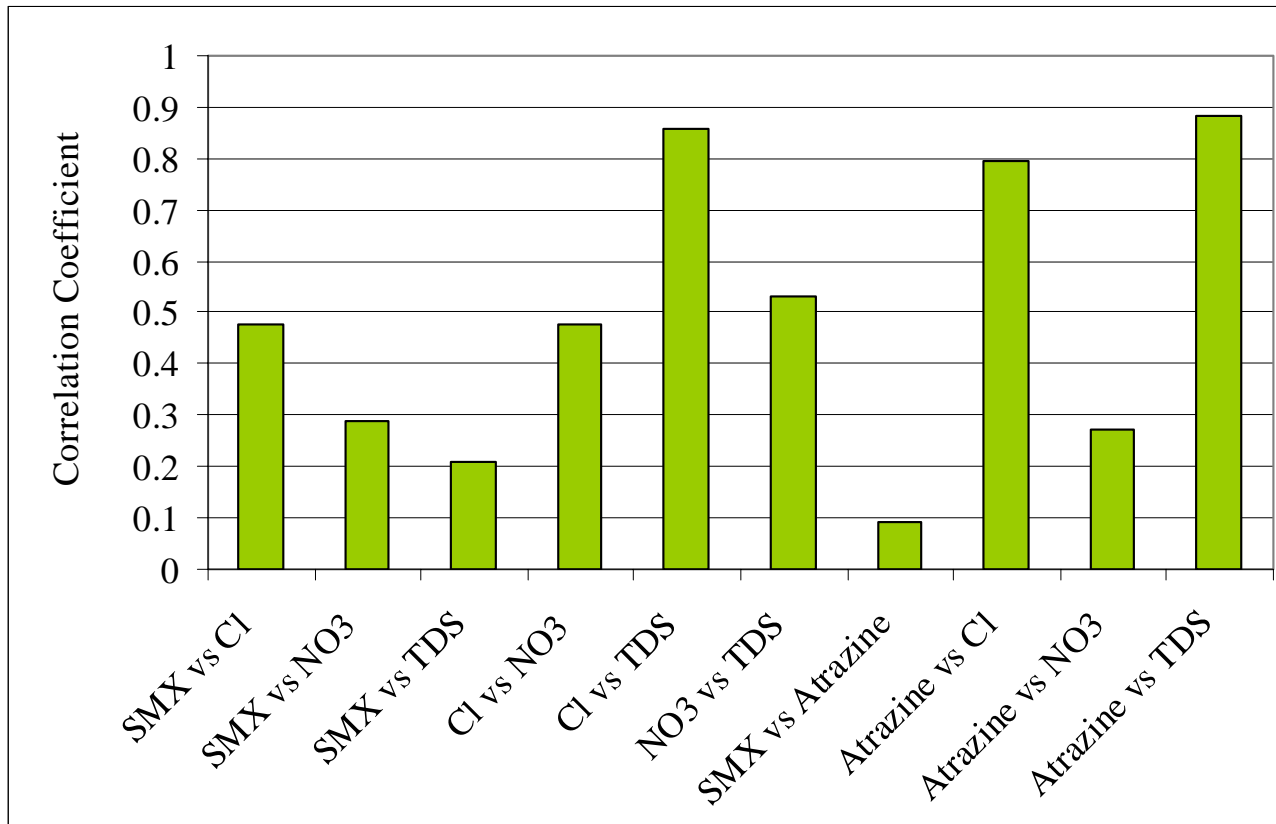
### ■ Moderate:

- 50-300 septic tanks /mi<sup>2</sup>





# Correlation Between Sulfamethoxazole (SMX), Atrazine, Chloride (Cl), Total Dissolved Solids (TDS) and Nitrate (NO<sub>3</sub>)



■ **Question:**  
□ **Is atrazine present in domestic wastewater?**

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# Summary

- PPCP findings are consistent with those of other investigators of ground water affected by onsite wastewater disposal
  - Coliphage results present implications for suitability as indicators of fecal contamination in ground water
  - We are left with questions:
    - Human and aquatic health effects
    - Potential synergistic or additive effects of exposure
    - Role of aquifer properties and water quality in controlling sorption, degradation and coliphage survival and attenuation in subsurface
    - Investigate occurrence of atrazine
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